A CONTROLLER THAT TUNES ITSELF

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In control theory, one of the biggest problems is knowing the system you are working with. A controller made for one machine may fail spectacularly if applied to another slightly different machine, or if something in the machine changes over time. This is where adaptive control comes in – if the controller can automatically find out how the machine behaves, differences between different machines can be identified and compensated for, and changes that appear over time can be tracked and controlled.

Tetra Pak had a machine where unknown and time-varying parameters were causing stability problems in a controlled liquid level, and wanted an adaptive controller capable of maintaining stability on different machines and in different conditions. An adaptive controller was designed using a system identification approach: The machine parameters are found by looking at the way the control signal affects the controlled level, and when the machine is known, subsequent control actions can be compensated to make the machine behave like a known reference machine.

To allow quick prototyping and testing, a model of the machine was created from first principles and implemented using Mathworks Simulink, and the adaptive controller was designed using Simulink blocks and Matlab function blocks that connected to the process model. When the controller was finished and able to identify and stabilize the simulated process, the controller was transferred to PLC code using Simulink PLC Coder and tested on a real machine. This design process makes it easy to go between drawing board, model and real machine and back.

The experiment made to test the controller on the real machine was designed to test two criteria: That the controller could identify a new machine from a reasonable initial guess, and that the adaptive controller could track process changes appearing over time. This was accomplished by purposely disturbing the control signal in a known way and letting the adaptive controller identify the new setting, both on startup and when the machine is already running.

Testing on the real machine revealed that the process model was very accurate and that the adaptive controller performed well. The adaptive controller could identify the machine from a wide range of initial conditions, and could track changes over time.

Tetra Pak were pleased with the performance of the adaptive controller, and are investigating the possibility of implementing the controller in future machines.

The thesis *Adaptive Control of an Integrator with Unknown Dead-Time* by Magnus Dagbro is available at http://www.control.lth.se/publications